REMARKS

Claims 1 and 3 are pending in this application. Claims 1 and 3 have been amended to further distinguish over the prior art references. Support for the amendments can be found in the specification as originally filed. No new matter has been added.

Claims 1 and 3 stand rejected under 35 U.S.C. §103(a) for obviousness over U.S. Patent No. 3,901,690 to Philip et al. (hereinafter "Philip") or U.S. Patent No. 4,793,875 to Larson (hereinafter "Larson").

Amended independent claim 1 is directed to steel having excellent abrasion resistance. The steel consists essentially of 8.0-35.0 wt. % Cr, 0.05-0.65 wt. % C, up to 1.0 wt. % Mn, 0.05-3.0 wt. % of at least one of Ti, Nb, Zr, V and/or W, the balance being essentially Fe. The steel structure has a total amount of Ti, Nb, Zr, V and/or W carbide precipitate distributed in the steel matrix adjusted to 0.1 wt. % or more. The steel is a cold-rolled steel sheet.

Amended independent claim 3 is directed to an abrasion resistant steel. The steel consists essentially of 8.0 to 35.0 wt. % Cr, 0.05 to 0.65 wt. % C, up to 1.0 wt. % Mn, and at least one of 0.05 to 1 wt. % Ti and 0.05 to 1.50 wt. % Nb wherein an aggregate of Ti + Nb is 0.50 to 2.0 wt. %, with the balance being essential Fe. Optionally the steel includes one or more metals selected from the group consisting of Zr, Al and W in an aggregate summed with Ti + Nb up to 3.0 wt. %, as well as optionally one or more of 0.2-5.0 wt. % Ni, 0.1-3.0 wt. % Mo and 0.2-3.0 wt. % Cu. The steel structure has a total amount of Ti, Nb, Zr, V and/or W carbide precipitates distributed within a steel matrix in an amount of at least 0.1 wt. %. The abrasion resistant steel is a cold-rolled steel sheet.

Philip discloses a steel product having columbium (Nb or Cb) and carbon in proportions which form idiomorphic columbium carbide of a controlled particle size to improve resistance to abrasive wear. The presence of a small amount of at least one of titanium, zirconium or hafnium is utilized to ensure that at least an effective amount of the idiomorphic type of columbium carbide is formed during solidification of the steel. As detailed below, the steel product of Philip is designed for use as dies and other significantly hardened products.

Larson discloses an abrasion corrosion resistant casting alloy. The abrasion resistant properties are achieved by performing a heat treatment including solution treating, heating, and furnace cooling.

Neither Philip nor Larson teach or suggest a steel with excellent abrasion resistance that is a cold-rolled steel sheet as in amended independent claims 1 and 3. Moreover, both references lack any suggestion that the steel product should be modified in a manner required to meet amended independent claims 1 and 3.

<u>Philip Does Not Teach or Suggest A Cold-Rolled Steel Sheet</u>

Philip is specifically directed to forged tool steels or high-speed steels, i.e. A.I.S.I. type H12 and A6. The tool steels or high-speed steels of Philip could not be a cold rolled steel sheet as evidenced by high ratios present of Mo, W, and Co additives in Tables I, IV, and VI. Column 7, lines 2-5 and column 8, lines 23-27 of Philip, disclose that the tool and high-speed steels of Philip are utilized for dies such as hot work forging dies, hot work extrusion dies, as well as dies used in cold-work processes such as blanking, coining, thread-rolling, and trimming. For such uses, it is necessary to enhance the strength of the steel by heat treatment. Therefore, the steel of the Philip invention contains great amounts of solution hardening elements, Mo, W, and Co (other than Nb) in order to harden the steel by heat. The necessity of these additives in Tables I, IV, and VI, illustrates all of the samples containing Nb, Mo, Co, V and W at a ratio above 3.0 in total. The addition of Mo, W, and Co at such high ratios makes the steel so hard before heat treatment, that the steel would be difficult to cold roll and therefore the steel product of Philip could not be a cold-rolled steel sheet.

Furthermore, there is no motivation in Philip to develop a cold-rolled steel sheet because the H12 and A6 steels would <u>not</u> be cold-rolled. It is well-known in the art that tool steels and high-speed steels are not cold-rolled. Moreover, it is well-known in the art that dies are not manufactured by cold-rolling. Dies are conventionally manufactured by hot-forging a steel ingot and machining the forged steel, and not by cold-rolling. Because the Philip product is necessarily a non-cold-rolled product, Philip provides no motivation to produce a cold-rolled steel sheet as required in amended claims 1 and 3. To the extent that the amount of columbium carbide precipitates of the Philip product is similar to that of the claimed sheet, the claimed feature of the steel being a cold-rolled sheet is simply not taught

or suggested by Philip. As such, the steel of Philip must be significantly different from the claimed steel sheet. Moreover, since the Philip steel is used for dies, such products would not be cold-rolled and therefore Philip actually teaches away from a cold-rolled steel sheet. Therefore, it is clear that Philip cannot teach or suggest a cold-rolled steel sheet as in amended independent claims 1 and 3.

Additionally, Philip does not teach or suggest the combination of features of (i) a cold-rolled steel sheet and (ii) 0.05-3.0 wt. % of at least one of Ti, Nb, Zr, V and W. As indicated above, Philip does not teach or suggest a cold rolled steel sheet. Additionally, Philip does not teach or suggest controlling the content of at least one of Ti, Nb, Zr, V and W to the low levels of 0.05-3.0 wt. %. The higher ratios (> 3.0 wt. %) of Ti, Nb, V and W as evidenced in Table I of Philip produces a hard steel. Steel with such hardness would not be cold-rolled. Therefore, Philip does not teach or suggest the combination of a steel having 0.05-3.0 wt. % of at least one of Ti, Nb, Zr, V, and W being a cold-rolled steel sheet.

<u>Philip Does Not Teach the Cr Range</u>

Additionally, the Philip patent principally aims at an improvement in wear resistance of a tool steel or high-speed cutting steel, such as AISI type A6, type H11, or type H12. Cr is added to these types of steels in order to improve quenchability and wear resistance. In this sense, Cr content is typically controlled to 4.75-5.50% for types of H11 and H12 steel, and to 0.90-1.2% for a type A6 steel.

The Philip patent discloses addition of Cr at a relatively low ratio. For instance, all of the examples in Table I belong to type H11 (i.e. more than 5% Cr), all of the examples in Table IV belong to type A6 (i.e., not more than 1.1% Cr), and all the examples in Table VI belong to the high-speed cutting Mo-based steel. While there is the wording of "up to about 19% chromium" in claim 1 of the Philip patent, the preferred compositions disclosed in the Philip patent do not exceed 5.5% Cr. Hence, the Philip patent clearly suggests to persons skilled in the art that the Cr content should not exceed 5.5%.

In contrast, the addition of Cr in the present invention aims at an improvement in corrosion resistance. Since precipitation of chromium carbide unfavorably degrades the corrosion resistance of steel, the present invention seeks to inhibit the precipitation of chromium carbide. To this end, the lower limit of Cr content is controlled to 8% (preferably

11%). An addition of chromium above 35% degrades the toughness of the steel. With a range 8-35% of Cr, the present invention steel belongs to ferritic or martensitic stainless steel, that is different from the alloyed steel or high-speed cutting steel as disclosed in the Philip patent.

Claim 3 Further Defines Over Philip with the Ti and Nb Range and Aggregate Formula

Additionally, Philip does not teach or suggest an abrasion resistant cold-rolled steel sheet having at least one of 0.05 to 1 wt. % Ti and 0.05 to 1.50 wt. % Nb, with an aggregate of Ti and Nb of 0.50 to 2.0 wt. %, as in amended independent claim 3. Philip fails to teach or suggest a criticality of Nb and/or Ti individual ranges, or in the aggregate (Nb + Ti) range of 0.50-2.0 wt. %. It will be seen in Table I of Philip that the Nb + Ti aggregate content for all of the example numbers 1-8 of Philip exceeds 2.5 wt. %. Additionally, the cold-rolled steel sheet of the present invention is formed to various product shapes by pressing, drawing or bending and is, therefore, work-hardened. Due to the work-hardening, there is a restriction on the addition of alloying elements which harden the steel sheet. Clearly Philip does not fairly suggest the alloy in amended independent claim 3. For the foregoing reasons discussed hereinabove in connection with amended independent claims 1 and 3, Applicants respectfully request reconsideration of independent claims 1 and 3.

Larson Does Not Teach the Mn Content

Larson also does not teach or suggest a cold-rolled steel sheet as in amended independent claims 1 and 3. The present invention is directed to a cold-rolled steel sheet, whereas Larson is directed to abrasion resistant steel castings as an improvement of ASTM A532. Additionally, Larson does not teach or suggest a cold-rolled steel sheet having up to 1.0 wt. % Mn as in amended independent claim 1. The Mn content in the present invention is utilized as a deoxidizing agent during steel making and is accordingly controlled to 1.0 wt. % or less. Larson discloses an Mn content of 3-7.0 wt. % to control dissolution of nitrogen. Because steel of Larson includes high levels of Cr (26-34 wt. %), higher Mn is employed to minimize toughness losses. The intensified dissolution of nitrogen at a higher ratio necessitates the addition of Mn at a ratio of 3.0 wt. %, which clearly exceeds up to 1.0 wt. % of Mn in amended independent claims 1 and 3. Furthermore, the Mn effect on dissolution of nitrogen is limited to a cast steel, and not applied to a steel sheet manufactured by a rolling

process. Therefore, Larson does not teach or suggest a cold-rolled steel sheet as in amended independent claims 1 and 3 and, moreover, does not teach or suggest a cold-rolled steel sheet excellent in abrasion resistance, including up to 1.0 wt. % Mn as in amended independent claims 1 and 3. For the foregoing reasons, reconsideration of the rejections of independent claims 1 and 3 is respectfully requested.

In view of the foregoing amendments and remarks, reconsideration of the rejections and allowance of claims 1 and 3 are respectfully requested.

Respectfully submitted,

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